ME 270 – Spring 2010

Final Examination

Please review the following statement:

I certify that I have not given unauthorized aid nor have I received aid in the completion of this exam.

Signature: ________________________________

INSTRUCTIONS

Begin each problem in the space provided on the examination sheets. If additional space is required, use the yellow paper provided to you.

Work on one side of each sheet only, with only one problem on a sheet.

Please remember that for you to obtain maximum credit for a problem, your work must be clearly and completely presented, i.e.

- The coordinate system must be clearly identified.
- Where appropriate, free body diagrams must be drawn. These should be drawn separately from the given figures.
- Units must be clearly stated as part of the answer.
- You must carefully delineate vector and scalar quantities.

If the solution does not follow a logical thought process, it will be assumed in error.

When handing in the test, please make sure that all sheets are in the correct sequential order and make sure that your name is at the top of every page that you wish to have graded.

Instructor’s Name and Section:

Section 1: J. Jones 9:30 – 10:20 a.m.  Section 2: S. Dyke 2:30 – 3:20 p.m.

Problem 1 __________

Problem 2 __________

Problem 3 __________

Problem 4 __________

Total __________
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PROBLEM 1 (30 points)

PROBLEM 1A. (5 points)

**GIVEN:** Two blocks are stacked on top of each other on the floor. The friction coefficient is 0.2 between all contacting surfaces (Take this to be both the static and kinetic coefficient of friction). Then, the horizontal 10 N force is applied to the lower block.

**FIND:** What is the horizontal component of the force exerted by the floor on the lower block?

\[ F_t = 10 \text{ N} \]

PROBLEM 1B. (10 points)

**FIND:** The members of a truss are connected to the gusset plate. If the forces are concurrent at point O, determine the magnitudes of F and T for equilibrium. Take \( \theta = 30^\circ \).

\[ F = 10.2 \text{ kN} \]
\[ T = 13.3 \text{ kN} \]
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PROBLEM 1C. (5 points)

GIVEN: A free body diagram including blocks 1, 3, 6, and the cords connecting them, is to be drawn for this system.

FIND: Which is the correct free body diagram (circle your answer)?

- (a)
- (b)
- (c)
- (d)
- (e)
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PROBLEM 1D. (10 points)

**GIVEN**: Determine the force in members BE and ED of the truss and state if the members are in tension or compression. Set $P_1 = 2 \text{ kN}$ and $P_2 = 1.5 \text{ kN}$. Use the method of sections.

\[ F_{BE} = -2.00 \text{ kN} = 2.00 \text{ kN} \, \text{C} \]

\[ F_{ED} = -2.60 \text{ kN} = 2.60 \text{ kN} \, \text{C} \]
PROBLEM 2. (25 points)

**GIVEN:** Due to the constraint, the 0.5-kg pin C travels along the path described in the diagram. Arm OA rotates counterclockwise with an angular velocity of 2 rad/s and an angular acceleration of 0.8 rad/s² at the particular instant when θ = 30° Note that the cylinder is in contact with only one edge of the smooth slot, and the motion occurs in the horizontal plane.

**FIND:**

a) Determine the radial component of the acceleration, \( a_r \), at this instant. (6 points)
b) Determine the transverse component of the acceleration, \( a_θ \), at this instant. (6 points)
c) Draw a free body diagram of the cylinder. (6 points)
d) Determine the force exerted by the arm OC on the cylinder at this instant. (7 points)

\[
a_r = 4.397 \text{ m/s}^2
\]
\[
a_θ = -1.984 \text{ m/s}^2
\]
\[
F_{OC} = 0.277 \text{ N}
\]
\[
N = 2.539 \text{ N}
\]
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PROBLEM 3. (20 points)

PROBLEM 3A. (10 points)

FIND: The 10 lb block A travels to the right at $v_A = 2$ ft/s at the instant shown. Determine the velocity of B at this time. Block B has a weight of 20 lb.

PROBLEM 3B. (10 points)

FIND: The device shown is used to produce the experience of weightlessness in a passenger when he reaches point A, $\theta=90^\circ$, along the path. If the passenger has a mass of 75 kg, determine the minimum speed he should have when he reaches A so that he does not exert a normal reaction on the seat. The chair is pin-connected to the frame BC so that he is always seated in an upright position. During the motion his speed remains constant.

$V = 9.90$ m/s
PROBLEM 4. (25 points)

**GIVEN:** A particle has an initial speed of 27 m/s. If it experiences a deceleration of \( a = -6t \) (m/s\(^2\)) where \( t \) is in seconds, then

a) Determine an expression for the velocity, \( v \), in terms of time, \( t \)? (13 points)
b) Determine an expression for the position, \( s \), in terms of time, \( t \)? (12 points)

\[
v = 27 - 3t^2 \quad \text{m/s}
\]

\[
s = 27t - t^3 \quad \text{m}
\]